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Three new species of *Hypogymnia* (Ascomycota: Parmeliaceae) from the Bering Sea region, Alaska and Russia

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Abstract: *Hypogymnia castanea* and *H. fistulosa* are newly described species of lichenized fungi (Ascomycota: Parmeliaceae), apparently restricted to oceanic tundra in the Bering Sea region. *Hypogymnia castanea* is so far known in Alaska only from the Seward Peninsula; it is also found in far east Russia. *Hypogymnia fistulosa* occurs at numerous localities on the Aleutian Islands, other islands in the Bering Sea, and the Seward Peninsula. *Hypogymnia lugubris* ssp. *beringiana* is elevated to the species level because of numerous morphological, chemical, and geographic differences from *H. lugubris* in the southern Hemisphere. *Hypogymnia beringiana* is a rare species from Alaska and Russia.

Key words: Aleutian Islands, Bering Sea, far east Russia, *Hypogymnia beringiana, Hypogymnia castanea, Hypogymnia lugubris, Hypogymnia fistulosa,* lichenized fungi, lichens, Seward Peninsula.

Introduction: Despite the presence of some puzzling *Hypogymnia* taxa in northern regions, the genus has not been closely scrutinized in Alaska since Krog (1968). Goward and McCune (1993) separated *H. apinnata* Goward & McCune from *H. enteromorpha* (Ach.) Nyl., including records for *H. apinnata* from coastal Alaska out to the far end of the Aleutian Islands, Attu Island. Another recently described species, *H. canadensis* Goward & McCune (2007), occurs in southeast Alaska, but this species does not occur in far northern or Beringian regions. Still, problems in Alaskan species of *Hypogymnia* remain. The current paper deals with three of these problems; others await a broader treatment of Alaskan *Hypogymnia*.

Two species of *Hypogymnia* from the Bering Straits region of Alaska have been recognized for decades, but never formally described. Specimens collected by Krog in 1969 were deposited long ago in the herbarium of the British Museum, with notes indicating that they were to serve as types. Here we describe the species and give additional localities from Alaska and Russia. A third species, *H. beringiana*, previously known as *Hypogymnia lugubris* (Pers.) Krog ssp. *beringiana* Krog, was previously reported from only from two localities (St. Paul and Nunivak Islands) in the Bering Sea, Alaska. Its range is now extended to a handful of sites in the Bering region and one site in Russia on the Arctic Ocean.

Thin-layer chromatography (TLC) for lichen substances followed procedures and solvent systems A and C of Culberson et al. (1981) and aluminum-backed silica gel plates (Merck 5554/7 Silica gel 60 F_{254}). We extracted fragments of specimens in acetone at room temperature. No attempt was made to distinguish atranorin from chloroatranorin.

Hypogymnia beringiana (Krog) McCune, comb. nov. (Figures 1-7, 20)
Hypogymnia lugubris (Pers.) Krog *ssp. beringiana* Krog. Norsk Polarinst. Skr. 144:99. 1968.

Type: U.S.A. Alaska: Bering Sea District: St. Paul Island, J. M. Macoun 71d (holotype: E, seen by Krog, isotype: US!).

Description: Thallus suberect and imbricate to erect, to 5 cm tall; texture cartilaginous; branching isotomic dichotomous to irregular, with subcontiguous or separate lobes, adventitious budding rare; upper surface pale greenish gray with sparse to dense black mottling, in exposed microsites becoming dark brown or dark gray near the lobe tips, smooth, epruinose; lower surface black, rugose, sparsely perforate; lobe profile even to ± nodulose; lobe width 0.8–3.0 mm; lobe width/height ratio 1-3:1; lobe tips and axils sparsely perforate, medulla hollow, ceiling of cavity white to dark brown, floor of cavity dark; soredia, isidia, and lobules absent. Apothecia unknown.

Chemistry: Cortex K+ yellow, C-, KC-, P+ pale yellow; medulla K+ slow reddish brown, C-, KC+ orange-red, P-. TLC: atranorin, physodic acid, and accessory 3-hydroxyphysodic acid.

Habitat and substrate: Oceanic tundra, on mosses or detritus, or rock.

Distribution: Alaska (Aleutian Islands and islands in the Bering Sea) and Russia. The sole record from Russia, Mattson 3114 (Figs. 5-6), is uncertain. The location is distant from the Bering Sea, occurring near the Arctic Ocean at 117°E, while the Bering Strait is at 173°W. The morphology of the specimen is not typical compared to other specimens we have seen, but it seems closer to *H. beringiana* than any other described species.

Krog (1968) described *H. lugubris* ssp. *beringiana*, apparently a rare northern hemisphere relative of the common subantarctic and austral species, *H. lugubris*. Although the

type of the Beringian subspecies strongly resembles *H. lugubris*, it differs from material in the southern hemisphere in several respects. First, *H. lugubris* in the southern hemisphere is typically P+ red-orange, containing physodalic and protocetraric acids, while *H. beringiana* is always P-, containing physodic acid and accessory 3-hydroxyphysodic acid. Furthermore, the lobes of *H. lugubris* are generally imperforate, while *H. beringiana* is sparsely to moderately perforate on the lower surface and lobe tips. Krog (1968) noted other morphological differences: material from the southern hemisphere has more predominant isotomic dichotomous branching, a more deeply wrinkled lower surface, the medulla with loose hyphae forming an arachnoid layer with strands oriented more or less parallel and longitudinally, and medullary hyphae that are commonly not blackened. The Beringian material appears to be related to the austral species, but surely populations in the two areas are reproductively isolated, and likely have been for a long time. Given the reproductive isolation and the morphological divergence in multiple characters, it seems appropriate to recognize the northern material at the species level.

Hypogymnia beringiana may also be closely related to *H. fistulosa,* although typical forms differ conspicuously in morphology. One specimen cited here as *H. beringiana* (Attu Island, *Talbot 381*, WIS) is sparsely sorediate, and therefore might be referable to *H. fistulosa*, but is otherwise similar to *H. beringiana*. They have the same chemistry, both can be suberect, and both can have black mottling. They differ in that *H. beringiana* is typically (but not always) more robust than *H. fistulosa* and has a stronger tendency to be suberect or even erect, while *H. fistulosa* is usually smaller and appressed to somewhat suberect.

Specimens examined: ***U.S.A. Alaska:*** Aleutian Islands, Atka Island, Atka, 52.195°N 174.203° E, *Kobayashi 10* (TNS); Aleutian Islands, Attu Island, Cape Wrangell, 52.923°N 173.463 ° E, 286 m, *Talbot 381* (WIS); Amchitka Island, 51.5°N 179°W, *Sowl 015* (WIS); Bering Sea Distr., St Paul Island, 57.15°N 170.28°W, *Whitney s.n.* (US); St. Lawrence Island, Camp Nasayluk, 63.37°N 170.27°W, *Geist 166371* (UPS); St. Matthew Island, Glory of Russia Cape area, 60.547°N 172.926°W, 240 m, *Talbot SM97-333* (WIS). ***RUSSIA:*** Olenekskiy Bay, ca. 70 km WSW Terpyay-Tumsa Peninsula, 73.28° N 116.93° E, 160 m, *Mattson 3114* (UPS).

Hypogymnia castanea McCune & Krog, sp. nov. (Figs. 8-13, 20)

Thallus terricola, ad > 10 cm diametro, planiusculus; cortex superior subviridi-griseus ad brunneus vel atrobrunneus; lobi cavi, 0.8–2.0 mm lati; soredia vel isidia desunt; cortex inferior imperforatus, rugosus, niger; apothecia ignota. Medulla K-, C-, KC+ aurantiaca vel rubra, P+ aurantiaca vel rubra.

Type: U.S.A. Alaska: Bering Strait District, Seward Peninsula, north of Nome, Teller Road, 3 km west of Feather River, on schistous rock, 26 June 1969, 64.85°N 166.117°W, *Krog L56845* (holotype, O; isotype, BM barcode 763523).

Etymology: "castanea" refers to the chestnut-brown color of typical thalli.

Description: Thallus loosely appressed to imbricate, often forming planar sprays of lobes, less often suberect, to 10 cm broad; texture cartilaginous to papery; branching variable, adventitious budding occasional; upper surface pale greenish gray to more often brown or dark brown, usually glossy, smooth, epruinose, dark mottling present; lower surface black, rugose; lobes separate to imbricate; lobe profile even to ± nodulose; lobe width 0.8–2.0 mm; lobe width/height ratio 0.8 - 1.5; lobe tips and axils entire, lower surface sparsely perforate; medulla hollow, ceiling of cavity white, floor of cavity dark; soredia, isidia, and lobules absent. Apothecia unknown.

Chemistry: Cortex K+ yellow (often difficult to see because thallus is so dark), C-, KC-, P+ pale yellow; medulla K-, C-, KC+ orange-red, P+ orange-red. TLC: atranorin, physodic and physodalic acids (major), and protocetraric acid (minor).

Habitat and substrate: Oceanic tundra, on mosses or detritus, or rock, rarely on bark or wood.

Distribution: Seward Peninsula in Alaska and Chukotsky Peninula in Russia; as yet unknown from outside the Bering region.

Diagnostics: dark brown glossy with horizontal growth form, P+ orange medulla, and no apparent reproductive structures. In the field *H. castanea* resembles some forms of *H. subobscura* in color, orientation, and spacing of lobes. *Hypogymnia subobscura* differs in the P- medulla, the usual presence of perforations in at least some of the lobe tips, and often a more appressed growth form. Note, however, that perforations in *H. subobscura* are less frequent in the Arctic of eastern North America and Greenland.

Specimens examined: ***U.S.A. Alaska:*** Port Clarence ad fretum Bering, 65.25°N 166.5°W, *Almquist s.n.* (S, Vega Expedition, 1878-1880); NE of Nome, 64.717°N 164.067°W, *Krog* L*56847* (O); vicinity of Nome, Cabin Rock, 64.617° N 165.683°W, 210 m, *Krog* L*56846* (O); Kotzebue Quad, Hill 988, Bering Land Bridge Nat. Preserve, 66.07°N 164.577°W, 183 m, *Neitlich 3000, 3001* (herb. Neitlich); Nome County, Oregon Creek north of Nome-Teller Road, 64.683°N 165.733°W, 110 m, *Holt 20089* (herb. Holt); Seward Peninsula, near Nome, exclosure near Monument Rock, 64.575180N 165.50170W, 200 m, *Neitlich* 3003 (herb. Neitlich), *Holt 20157* (herb. Holt); *Holt 20082* (herb. Holt), *McCune 26460* (OSC). ***RUSSIA:*** Magadan Oblast, Chukchi Autonomous Okrugs, Chukotskiy Peninsula, 66.583° N 179.167° E, *Makarova 241* (BM).

Hypogymnia fistulosa McCune & Krog, sp. nov. (Figs. 14-20)

Thallus saxicola vel terricola, ad >10 cm diametro, imbricatus vel suberectus; cortex superior subviridi-griseus vel brunneus; lobi cavi, 0.3 - 1.5(2.0) mm lati; soredia apicalia et laminalia; cortex inferior imperforatus vel pertusus sparsus, rugosus, niger; apothecia ignota. Cortex K+ flavescens; medulla K+ lente rufa, C-, KC+ aurantiaca vel rubra, P-.

Type: U.S.A. Alaska: Bering Strait District, King Island, saxicolous on granitic rock, 24 June 1969, 64.983°N 168.05°W, *Krog L56844* (holotype, O; isotype, BM barcode 763524).

Etymology: "fistulosa" refers to the fistulose (or hollow) soralia formed on funnel-shaped lobe tips.

Description: Thallus appressed or loosely appressed, to 6(10) cm broad; texture cartilaginous; adventitious budding occasional; upper surface pale greenish gray to dark brown, epruinose, with black mottling; lobes contiguous to more often imbricate or suberect, smooth with angular depressions; lobe profile even to ± pinched-swollen; lobe width 0.3 - 1.5(2.0) mm; lobe width/height ratio 0.8 – 4.0; lobe tips and axils entire, lower surface entire or rarely with sparse perforations (perhaps from herbivory?); medulla hollow, ceiling of cavity brownish to white, floor of cavity dark; soredia present, in discrete soralia that are initially punctate, becoming capitate, then volcano-like and bursting in the centers; isidia lacking; lobules rare. Apothecia unknown.

Chemistry: Cortex K+ yellow, C-, KC-, P+ pale yellow; medulla K+ slow reddish brown, C-, KC+ orange-red, P-. TLC: atranorin and physodic acid (major), usually with 3-hydroxyphysodic acid (major, accessory).

Habitat and substrate: Oceanic tundra, on siliceous rock or detritus over rock.

Distribution: Of the three species treated here, *H. fistulosa* is the most broadly distributed in Alaska, occurring at numerous localities on the Aleutian Islands, other islands in the Bering Sea, the Seward Peninsula, and the Alaska Peninsula. So far it is unknown from Beringean Russia, but is to be expected.

Diagnostics: Thallus pale brown, brown, or pale greenish gray with black mottling, usually with more open and suberect branching than *H. bitteri*, along with distinctive funnel- or cannon-shaped soralia. The soredia form in discrete soralia that are punctate to capitate, becoming volcano-like and bursting in the centers.

Forms with imbricate to suberect lobes can be separated from *H. vittata* by the latter species having large, frequent perforations in the lower surface and often in the lobe tips, while *H. fistulosa* is only rarely perforate, and perhaps only through herbivore damage. Furthermore, the soralia of *H. vittata* are more often lip-shaped and only rarely funnelform or capitate like *H. fistulosa*. The cavity of *H. vittata* is blackened almost throughout, while the lobe ceilings are often brownish to white in *H. fistulosa*.

Forms of *H. fistulosa* that are more appressed, with contiguous lobes, can be similar at first glance to *Hypogymnia bitteri*, owing to the brownish coloration and terminal soralia. Although chemically similar to *H. bitteri*, the morphology of the soralia is quite different. In *H. bitteri* the soralia are usually terminal, often on short, lateral lobes, and in older individuals laminal soralia are common. In *H. fistulosa*, on the other hand, soralia may begin small and punctiform, but soon the lobe tip disintegrates, leaving a soredia-lined cylindric or funnel-shaped soralium. The lobes of *H. bitteri* are almost always contiguous, rarely imbricate, and almost never suberect, while *H. fistulosa* usually develops imbricate to suberect lobes, although portions of a thallus can be rosettiform with contiguous lobes.

Specimens examined: ***U.S.A. Alaska:*** Amchitka Island, 51.5°N 179°W, *Sowl 0154* (WIS); Bering Strait District, King Island, 64.983°N 168.05°W, *Krog L56848, L56849, L56850* (O); Izembek National Wildlife Refuge, Baldy Mountain, 56.95°N 162.79°W, 334 m, *Talbot 376, 399* (WIS); Semidi Islands, Choweit Island, 56.033°N 156.733°W, 10 m, *Talbot SEM060, SEM108* (WIS); Seward Peninsula, Pilgrim Hot Springs Road, N slope Kigluaik Mts, 65.053°N 164.763°W, 230 m, *McCune 26512* (OSC); Shumagin Islands, Simeonof Island, NE slope of Hill 1265, 54.902°N 159.280°W, 230 m, *Talbot 122* (WIS); St. Paul Island, 0.5 km NE of Telegraph Hill, 57.158°N 170.263°W, 100 m, *Talbot SP97-065*, *SP97-075* (WIS); St. Paul Island, 1 km S of Bogoslof Hill, 57.15°N 170.317°W, 30 m, *Talbot SP97-181* (WIS); St. Paul Island, Telegraph Hill, 57.15°N 170.267°W, 100 m, *Talbot SP97-022* (WIS).

Discussion: The cold oceanic tundra surrounding the Bering Sea is home to *Hypogymnia beringiana, H. castanea*, and *H. fistulosa*. While none of the species is abundant, they can be locally common on rock and tundra sod. *Hypogymnia vittata* sometimes occurs with these species (Fig. 20), but is much more wide ranging, though infrequent, in Alaska. This species is readily distinguished by large, gaping holes in the lower surface, the presence of terminal lip-shaped soralia (although sometimes soralia are sparse or absent), and the presence of narrow adventitious lateral lobes. Like all three of the new species, the upper surface of *H. vittata* is often conspicuously mottled with black and the branching is rather open.

The Bering Sea region is not well collected for lichens. We have seen very few specimens from Russia, and *H. beringiana* and *H. castanea* were among those. It seems likely that *H. fistulosa* will

also be found on the Russian side of the Bering Sea. In Alaska, *H. castanea* is so far known only from the Seward Peninsula, while *H. fistulosa* ranges more broadly, occurring at numerous localities on the Aleutian Islands, other islands in the Bering Sea, and the Seward Peninsula. So far none of the new species has been found in the somewhat warmer yet still oceanic climate of southeast Alaska.

The phylogenetic affinities of these species are unknown. Although *H. beringiana* is superficially similar to some taxa in the *H. lugubris* complex in the southern hemisphere, it also appears to have affinities to *H. fistulosa*. That species, in turn, at first glance resembles some forms of *H. bitteri*, but this may just be a superficial resemblance. *Hypogymnia castanea* is not clearly related to other Alaskan species, though its branching pattern and chemistry suggest an affinity with *H. krogiae* and *H. incurvoides*. Molecular data are needed to resolve their affinities.

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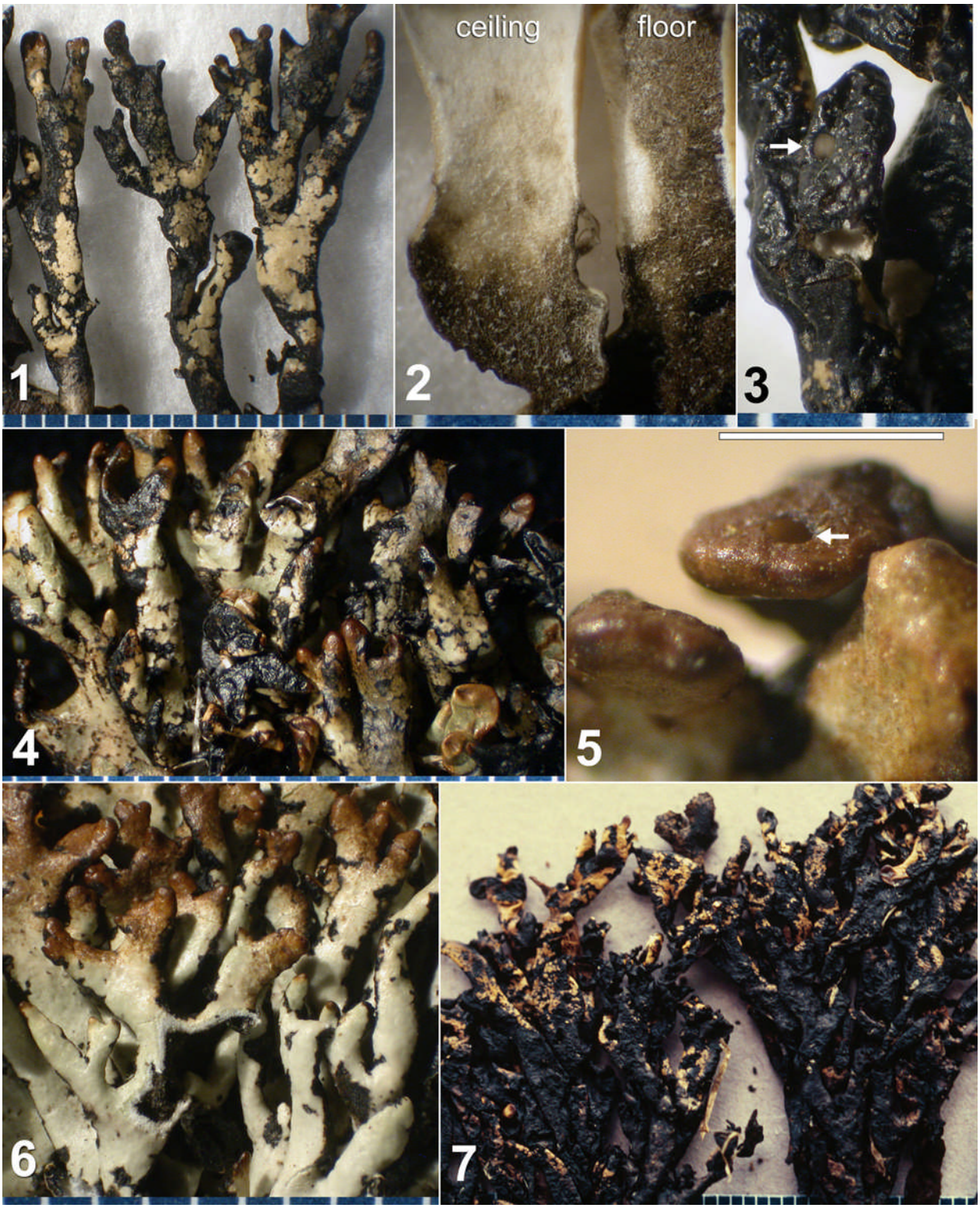
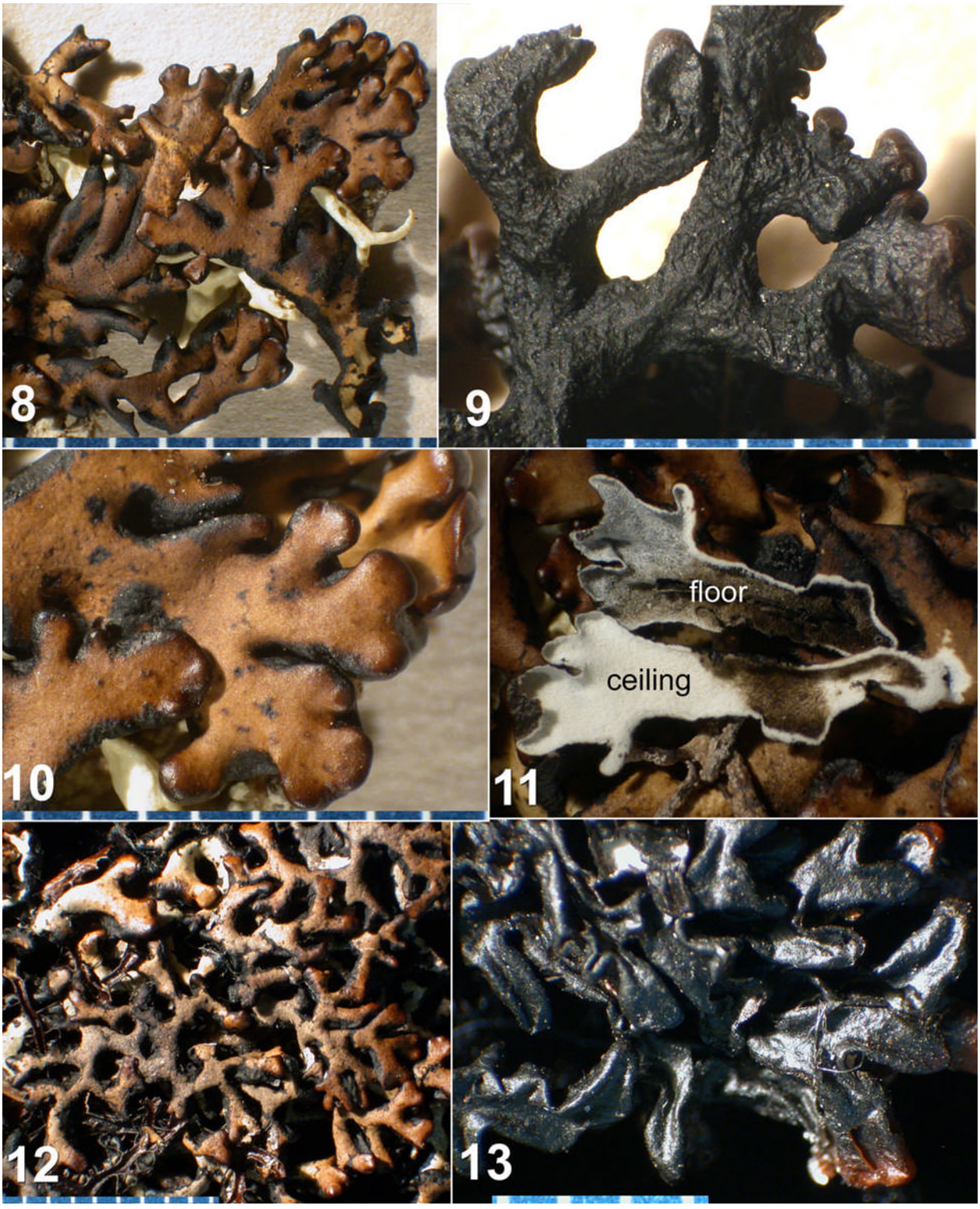
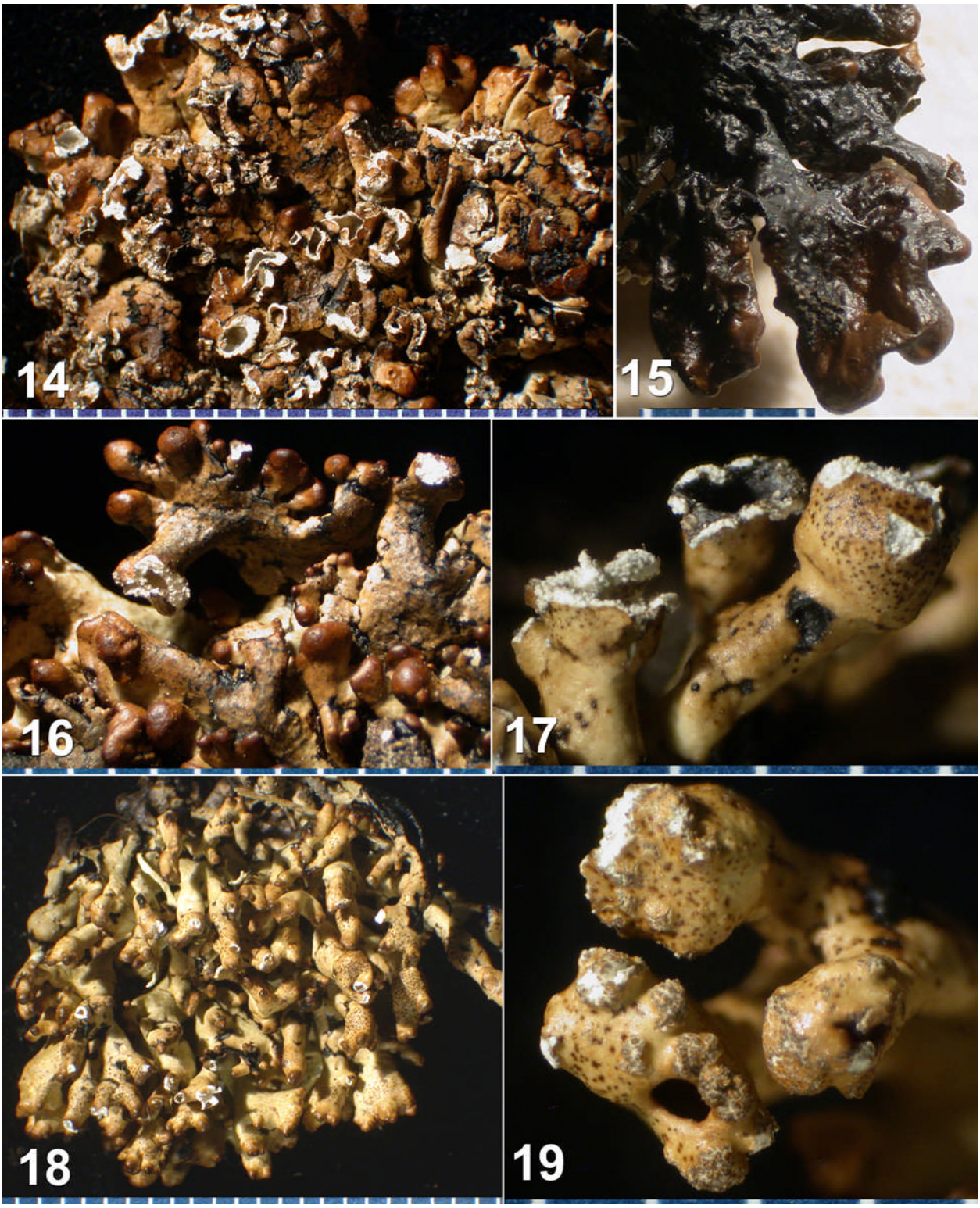


Figures 1-7. *Hypogymnia beringiana*. 1.— *Sowl 015*, habit; 2.— lobe cavity, showing ceiling and floor of cavity; 3.— perforation in lower surface (see arrow); 4.— *Talbot SM97-333*, habit; 5.— *Mattson 3114*, lobe tips, arrow shows perforation; 6.— habit; 7.— *Macoun 71d*, isotype (US), habit. Rulers in mm; scale bar 1 mm.



Figures 8-13. *Hypogymnia castanea*. 8.— *Krog L56847*, holotype (O), habit; 9.— lower surface; 10.— lobe detail, upper surface; 11.— lobe cavity, showing upper (ceiling) and lower(floor) of cavity; 12.— *Makarova 241*, habit; 13.— lower surface. Rulers in mm; scale bar 1 mm.



Figures 14-19. *Hypogymnia fistulosa*. 14.— *Krog L56844*, holotype (O), habit; 15.— lower surface; 16.— lobe detail, upper surface; 17.— *Talbot 399*, soralia; 18.— habit; 19.— lobe tips with incipient and young soralia. Rulers in mm; scale bar 1 mm.

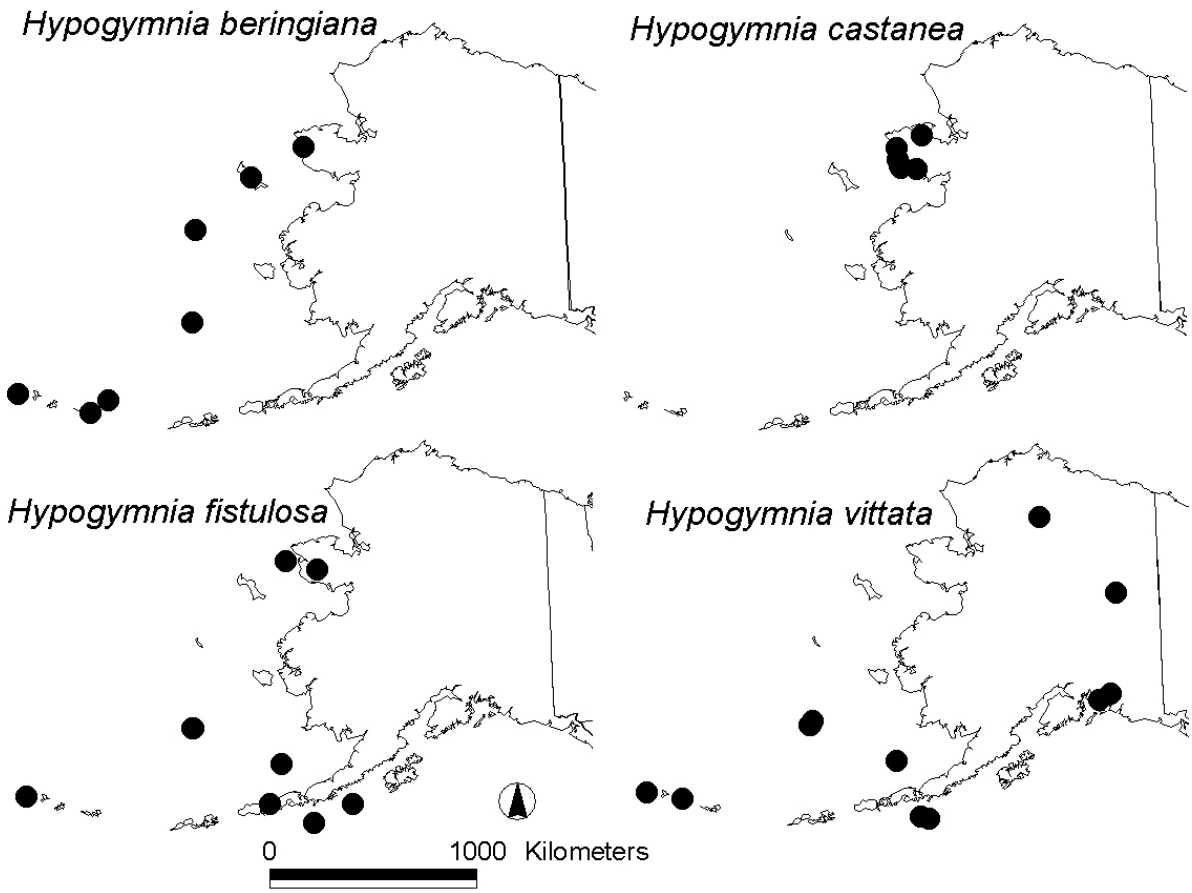


Figure 20. Distribution of selected *Hypogymnia* species in Alaska. Of the four species mapped, only one, *H. vittata*, is known from southeast Alaska (not shown). All except *H. fistulosa* are also known from far east Russia.